

# **Agricultural-based Life Cycle Assessment: Primary and Secondary data**

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# Outline

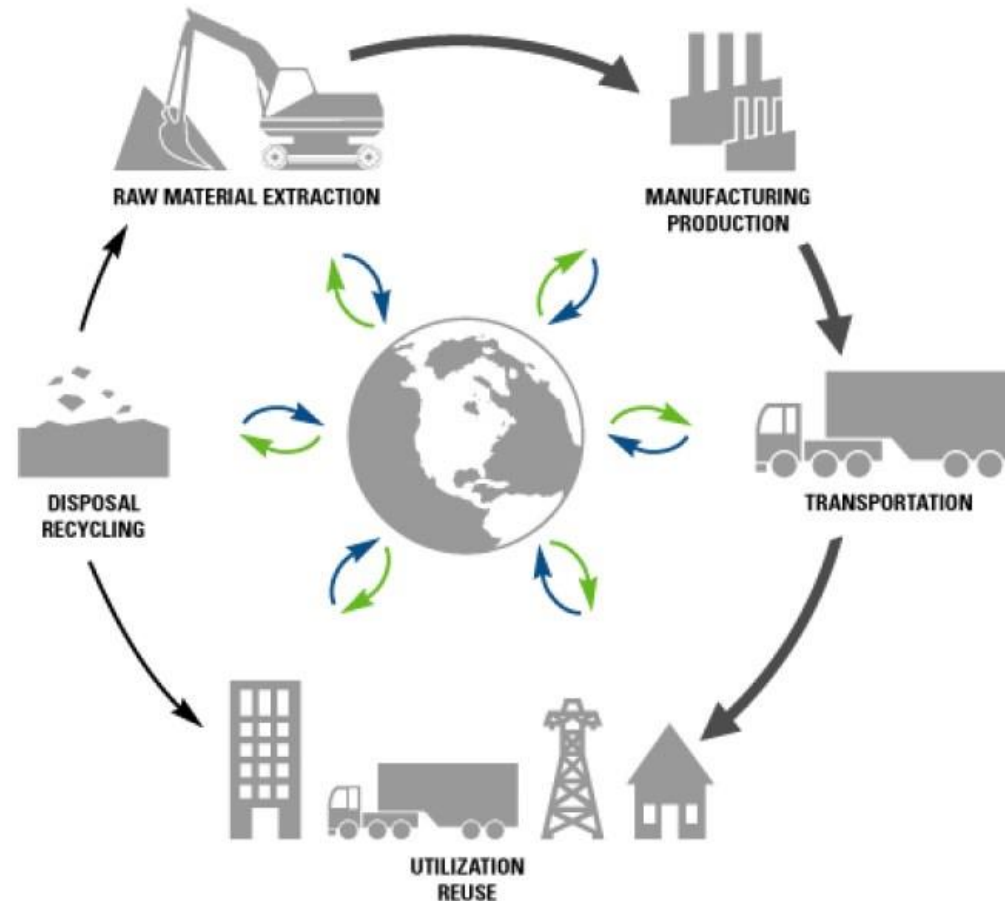
- Agricultural Systems in the LCA context
- Life Cycle Assessment (LCA)
- International Organization for Standardization (ISO)
- Environmental Product Declaration (EPD)
  - Product Category Rules (PCR)
- Primary data & survey methods
- Secondary data & LCI development protocols
- Assumptions

# Agricultural Systems in the LCA Context

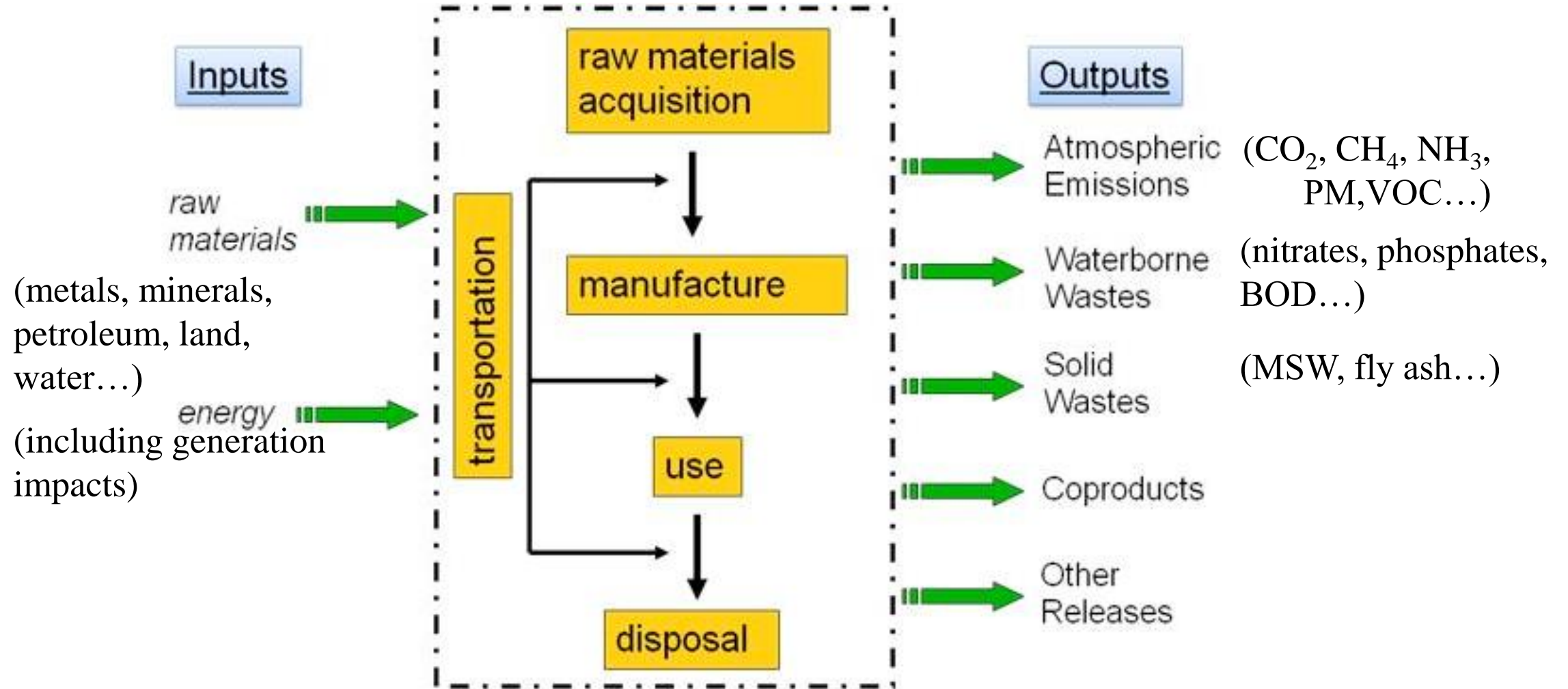
- Inherent variability in natural systems
  - Soils
  - Crops
  - Interactions between soil, water, and air
- Agricultural-related Processes
  - Irrigation
  - Fertilizer and pesticides
  - On-farm operations
    - E.g., tractor operations
  - Direct vs. Indirect emissions

# What is Life Cycle Assessment?

Life cycle assessment is an environmental accounting method to quantify resource inputs (e.g., fuel, fertilizer, pesticides, and water), and usable products (e.g., tomato), as well as waste and pollution coming out of a production system.

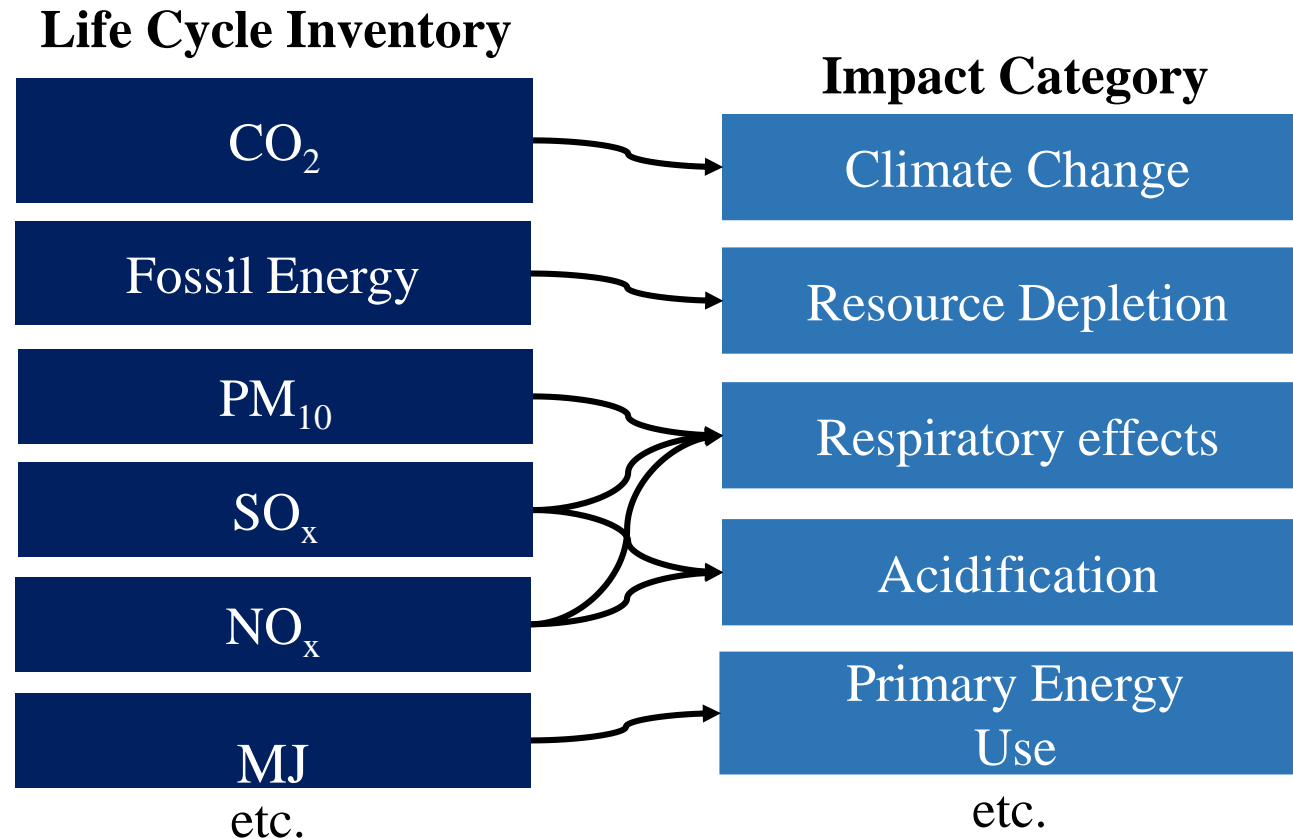


# LCA: An Environmental Accounting Tool



# Life Cycle Impact Assessment

Translate resources consumed or pollutants emitted into effects on humans or the environment.



# International Organization for Standardization

<https://www.iso.org/>

**ISO 14040:2006** Environmental management -- Life cycle assessment -- **Principles and framework**

**ISO 14044:2006** Environmental management -- Life cycle assessment -- **Requirements and guidelines**

**-Goal and Scope Definition**, e.g., define the system boundary.

**-Life cycle inventory analysis (LCI) phase**, e.g., detailed tracking of all the flows in and out of the product system.

**-Life cycle impact assessment (LCIA) phase**, e.g., the global warming impact from combustion of a fuel is calculated.

**Applies to all products**

# International Organization for Standardization

<https://www.iso.org/>

**ISO 14040:2006** Environmental management -- Life cycle assessment -- **Principles and framework**

**ISO 14044:2006** Environmental management -- Life cycle assessment -- **Requirements and guidelines**

**-Life cycle interpretation phase** - iterative process as the **testing of the quality and completeness of information** needs to be considered with respect to the validity of the **resultant impacts**.

-Reporting and critical review of the LCA

-Limitations of the LCA

-Relationship between the LCA phases

-Conditions for use of value choices and optional elements



# ISO & The International Environmental Product Declaration® System

<http://www.environdec.com/>

## ISO 14025:2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures

**-Establishes the principles and specifies the procedures for developing Type III environmental declarations.**

**-It specifically establishes the use of the ISO 14040 series of standards in the development of Type III environmental declaration programmes and Type III environmental declarations.**

**-Type III environmental declarations are primarily intended for use in business-to-business communication, but their use in business-to-consumer communication under certain conditions is not precluded.**

**Applies to specific products**

# ISO – Environmental Labeling Program

The ISO (International Organization for Standardization) has developed standards for the following three types of environmental labeling programs. Information about EPD is also given in separate heading.

## Type I

Labels

Pass-or-fail criteria

Examples:



## Type II

Any written or spoken environmental statement  
No third party verification  
No pass-or-fail criteria

## Type III

LCA based  
Third party verification  
No pass-or-fail criteria

Registered trademark:



# ISO – Environmental Labeling Program

Comparison between type I, II and III labeling:

	<b>Type I</b> Environmental labeling	<b>Type II</b> Self-declared environmental claims	<b>Type III</b> Environmental declarations
<i>Information</i>	Qualitative	Qualitative / quantitative	Quantitative
<i>Range</i>	Special products	All products and services	All products and services
<i>Quality check</i>	Verification of eco-labeling body	None	Third-party certification
<i>Receiver</i>	Consumers	Consumers/ professional purchasers	Professional purchasers

# Product Declaration

## Type III environmental declarations

➔ Search product (e.g., tomato or tomato paste)

On this page you can download the PCRs administered by the International EPD® System (free, but requires registration), participate in PCR development and provide comments on PCRs available on open consultation.

Search for PCRs

SEARCH

Search for a specific product



- ➔ Determine if there is a *product category rule (PCR)* for the selected product
- ➔ IF no, then...
- ➔ IF yes, then use the set rules to conduct the life cycle assessment and any complementary assessments.

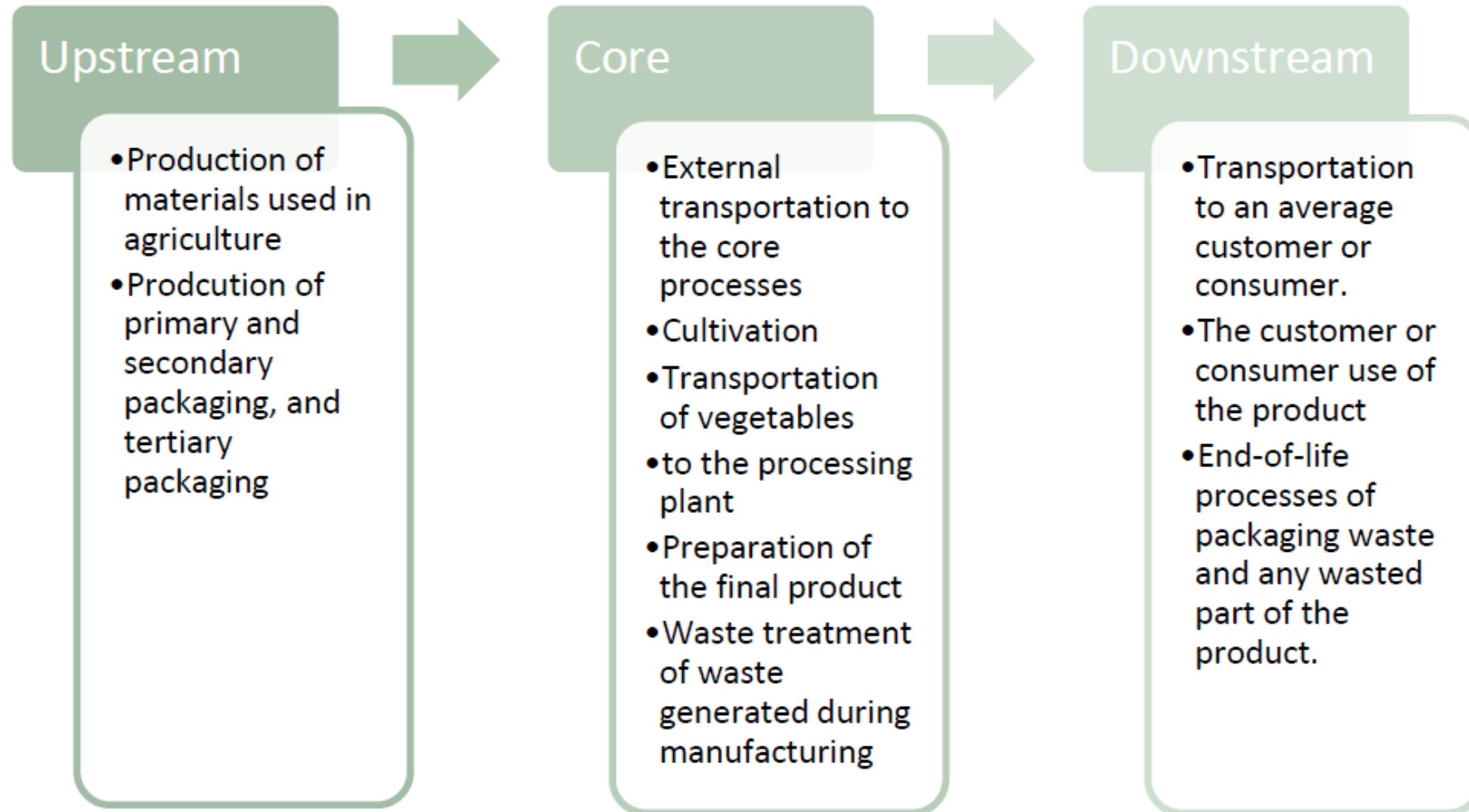
## Product category

Example: **Product Category Rule (PCR)** (2014:09 V1.01 UNCPC 2132 and UNCPC 2139): Vegetable juices, Plant milk and Other prepared and preserved vegetables, pulses and potatoes (expired 2017-05-21; being updated)

*Specific data* (also referred to as *primary data*) shall be used for the *Core Module*.

Specific data are gathered from the actual manufacturing plant(s) where specific processes are carried out and data from other parts of the life cycle traced to the specific product system under study, e.g. materials or electricity provided from a contracted supplier being able to provide data for the actual delivered services, transportation taking place based on the actual fuel consumption and related emissions, etc.

# Product Declaration Primary data – each phase is defined in the PCR



# Primary data – Survey process

- Develop **pilot survey**
  - Search and use available information to help develop the pilot survey – so it accounts for the factors (inputs, outputs, etc.) that can be used to accurately *characterize* the system of study.
  - Agricultural-related studies in California – critical resources:
    - UC Davis cost and return studies
    - Experts at UC Davis, including extension professionals
  - Develop *reference ranges*: while reviewing the literature to develop the pilot survey, collect any literature values reported for each factor selected to include in the survey.

# Primary data – Survey process

- **Survey formats**

- Discover the format/s your target audience prefer to use<sup>1</sup>.
- Example formats: Hard copy, Excel version, and Web or App version (e.g., using an iPad, an iPhone or another device)

<sup>1</sup>Can be assessed using a qualitative or a quantitative approach.



# Primary data – Pilot survey

UCDavis / Barilla / Morningstar / Ingomar Collaboration – Tomato Production in California  
 Contact: Kiara S. Winans; 530.564.9218

Year \_\_\_\_\_

Water district \_\_\_\_\_

County \_\_\_\_\_

Crop 1 alfalfa\_\_ cotton\_\_ dry bean\_\_ fallow\_\_ field corn\_\_ melon\_\_

Crop 2 alfalfa\_\_ cotton\_\_ dry bean\_\_ fallow\_\_ field corn\_\_ melon\_\_

Crop 3 alfalfa\_\_ cotton\_\_ dry bean\_\_ fallow\_\_ field corn\_\_ melon\_\_

**Irrigation**

<b>Source-1</b>	<b>Source-2</b>
surface water _____	canal name _____
well water/pumped _____	well depth _____

**Irrigation Method (circle)** drip or furrow

**If you use drip irrigation, how frequently do you replace your drip tape?**

Every 5 years \_\_\_\_\_

Other: \_\_\_\_\_

<b>Tractor Manufacturer (e.g., Ford)</b>	<b>Make</b>	<b>Year</b>	<b>Horsepower</b>
_____	_____	_____	_____
_____	_____	_____	_____

Survey Barilla\_for MorningStar Growers.xlsx

A	B
dry bean	
fallow	
field corn	
melon	
safflower	
sunflower	
wheat	
Other: _____	
Describe your rotation cropping system (e.g. 1 year corn, followed by 2 years tomato, etc.):	
_____	
_____	
What are the benefits of this cropping rotation system?	
_____	
_____	
Transplanted / Direct Seeding (for tomato)	
_____	
_____	
Between 2015 and 2005, have you changed your row spacing? total number of rows? number of _____	
_____	
_____	
Deeprip	
_____	
_____	



# Primary data – Pilot survey – Findings cont.

- Although the App version seemed like an attractive option and can be used by a grower when collecting field data, most growers preferred the Excel or Word versions for one or more of the following reasons:
  - (1) Accustomed to Word documents and hard copies
  - (2) Most data is stored in Excel files or other software programs
  - (3) The nature of the question we asked, i.e. 2005 and 2015 data that required them to search through archived files—stored as electronic or hard copy files.
- Once we completed the pilot survey, we used the feedback we received from survey respondents to modify the survey as needed before administering the final survey.

# Primary data – Pilot survey

## Take-home messages from pilot survey process:

- **Reference ranges** for each factor collected during the pilot survey development **helped to critically evaluate the data collected, as the data was being collected.**
- **Be mindful of the type of information you need to collect** through your survey process and use the format (hard copy, web version, other) that allows the respondent to most easily source their data, considering whether the data is real-time data collected in the field or stored data held in the office (as electronic or hard copy files).

## Web-based Survey Tools - basics

**Google docs:** They work really well on mobile, and can be sent simply by emailing a link (no one has to download anything). I totally recommend this route if possible, b/c it's probably the simplest both for you and for the farmers (provided they have internet access)

<https://docs.google.com/forms/>

**SurveyMonkey:** even more sophisticated online surveying capabilities, like branching forms (if answer == yes, show these questions next; if no, show other questions) <https://www.surveymonkey.com>

# Web-based Survey Tools - basics

**For online / offline-capable forms that are GPS-enabled (if you need location data as part of your survey)...**

**Ona** (<https://ona.io/features.html>), **Enketo** (<https://enketo.org/>), **ODK** (<https://opendatakit.org/>)

## **Enketo:**

You send out one survey to anyone you wish and all submissions get stored in the aggregate server (ODK Aggregate, KoboCollect or **Ona.io**).

**Qualtrics (UCDavis Agreement = free technical support)**

[www.qualtrics.com](http://www.qualtrics.com)

## **Institutional review board (IRB)**

A committee used in the United States that reviews, approves, and monitors any research involving humans.

The purpose of the IRB is to assure the rights and the welfare of humans participating as subjects in a research study.

For more information:

<http://research.ucdavis.edu/policiescompliance/irb-admin/>

## Secondary data

- Peer-reviewed data values that may come from peer-reviewed literature, government online databases, etc.
- Data obtained through a life cycle inventory database like GaBi (Think Step, 2016)
- *Life cycle inventory data* includes all of the inputs and outputs to produce a defined quantity of material (e.g., 1 kWh electricity) and the *meta data*.

## Secondary data – life cycle inventory *reference* data

- Life cycle inventory vs. *reference* life cycle inventory
  - A *reference* LCI is a type of secondary data
  - The life cycle inventory includes all the data you use to characterize your system-- primary data and secondary data (*reference* LCIs and literature values)



## Secondary data – *meta data*

- *Meta data* describes what the LCI is for, e.g., diesel production.
- Meta data should indicate the data source (location, author), etc.
- Meta data is often incomplete in inventory databases as well as peer-review literature.
  - That this information is incomplete is problematic if you want to assess the validity of your results for a specific region or compare LCA results between regions.

## Secondary data – life cycle inventory *reference* data

- What if the reference LCI you need is not available in the database (e.g., GaBi or Ecoinvent database)?

Approach 1: Identification of Chemical Structure & Functional Group

Approach 2: Identification of Chemical Family Name

Approach 3: Identification of Chemical Manufacturing

*We'll walk through approach 1.*

## Approach 1:

### Identification of Chemical Structure & Functional Group

- **Identify the material or product name**, e.g., Warrior.
- Type the name of the product into the Agrian (or Google) search engine to **obtain the MSDS and information about the product's active ingredients** (i.e. chemicals or other substances). <https://home.agrian.com>
- Find the **chemical's structure**: <https://pubchem.ncbi.nlm.nih.gov/>.

# Approach 1:

## Identification of Chemical Structure & Functional Group

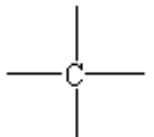
- Identify **the functional groups** using the Purdue University Chemical Functional Group look-up table:  
<http://chemed.chem.purdue.edu/genchem/topicreview/bp/2organic/function.html>
- Find a reference LCI for a chemical that matches the **chemical structure or functional group**.
- **Check** molar mass balance & ensure accurate accounting in LCIs

# Approach 1:

## Identification of Chemical Structure & Functional Group

### Common Functional Groups

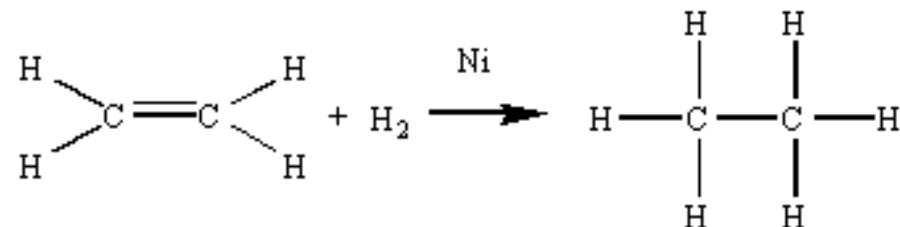
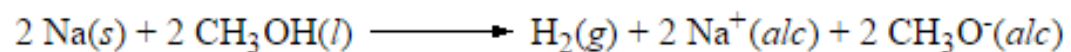
#### *Common Functional Groups*

<i>Functional Group</i>	<i>Name</i>	<i>Example</i>
	Alkane	CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub> (propane)
C=C	Alkene	CH <sub>3</sub> CH=CH <sub>2</sub> (propene)
C≡CH	Alkyne	CH <sub>3</sub> C≡CH (propyne)
F, Cl, Br, or I	Alkyl halide	CH <sub>3</sub> Br (methyl bromide)
—OH	Alcohol	CH <sub>3</sub> CH <sub>2</sub> OH (ethanol)
—O—	Ether	CH <sub>3</sub> OCH <sub>3</sub> (dimethyl ether)
—NH <sub>2</sub>	Amine	CH <sub>3</sub> NH <sub>2</sub> (methyl amine)

### Simple Structure

E.g., CH<sub>3</sub>CH<sub>2</sub>OH (ethanol)

### Oxidation-Reduction Reactions



### Final step:

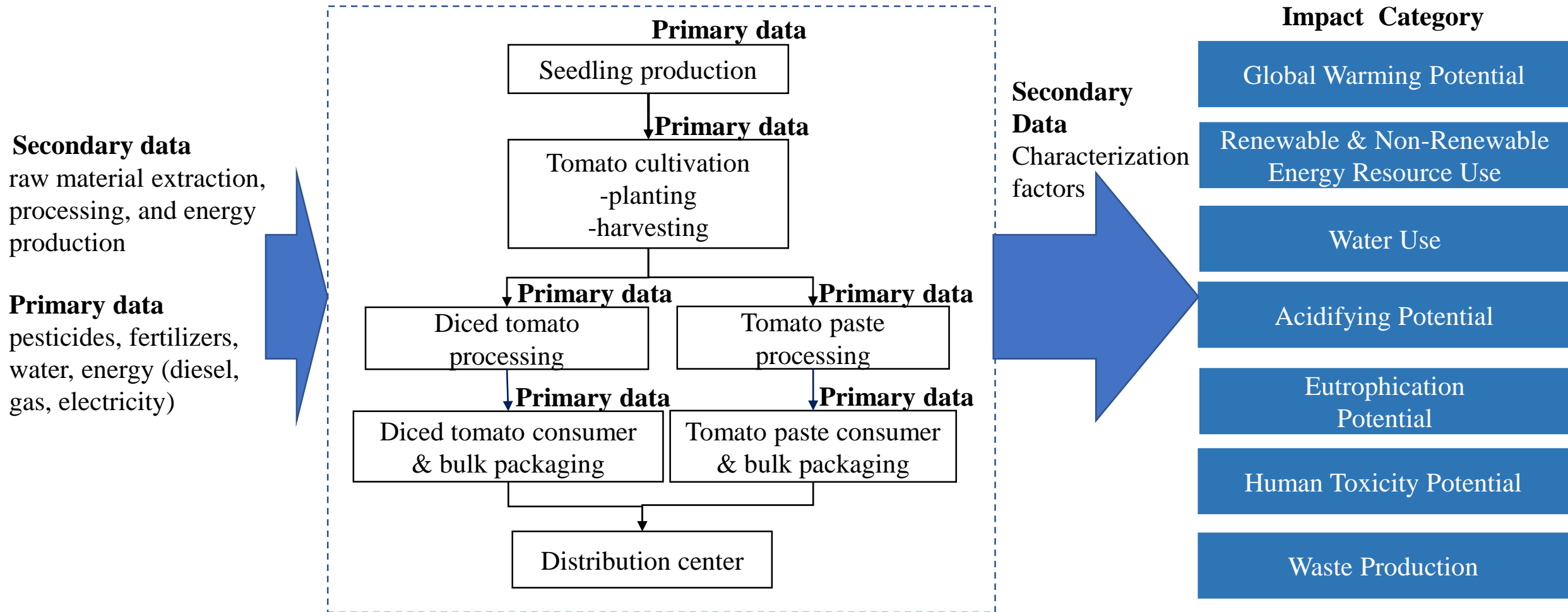
**Check** molar mass balance & ensure accurate accounting in LCIs

# Upstream or *background system* and the *foreground system*

- Upstream or *background system* and the *foreground system*
  - For diesel, the *background system* is the production of the oil (from oil rig, to refinery, to fuel vendor).
  - Where, the *foreground system* refers to the combustion of diesel fuel in a front-end loader used in composting operations.

**How do we plan for data collection?**

# Life cycle flow chart and data collection plan



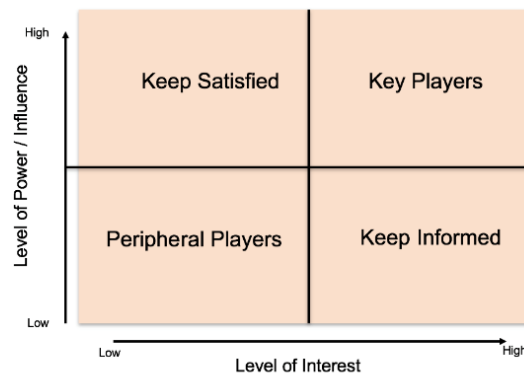
Primary data refers to data collected through the surveys; Secondary data refers to data obtained through GaBi Life Cycle Tool (Think Step, 2016)



# Data collection can be an iterative process

- **Develop a stakeholder map**
- **Define who you need to collect data from**
  - determine what incentives if any that party has to cooperate with you
  - if there are no incentives, see if there are some potential win-win options that will help to encourage the data exchange process, e.g., you provide the individual facility/firm their processed data that shows LCA results for GWP, etc.

Stakeholder Engagement Map



## Data collection can be an iterative process *cont.*

- Determine if the participant requires a **legal agreement** for the data exchange. If so, contact the Office of Research to request a non-disclosure agreement (NDA).

**FINE PRINT:** It is up to you to work with the Office of Research staff to ensure the language in the NDA meets the requirements of both parties.

For example, make sure the language in the NDA ensures you can use the data collected (in aggregated form or other) for publication, as deemed acceptable by all parties.

## Data collection can be an iterative process *cont.*

- Develop an **introductory document** to go along with your survey so the survey recipient has the appropriate context for the survey. And include the appropriate contact information!
- **Define the level of engagement and time requirement** (some of this information is useful for you only and some of it needs to be communicated with your intended respondent)
  - E.g., **How much time** will the survey(s) take to complete (per participant)?

## **Data collection can be an iterative process *cont.***

- **Define the level of engagement and time requirement** (some of this information is useful for you only and some of it needs to be communicated with your intended respondent)

-E.g., **How** many times throughout the survey/project do you hope to engage the participant and **why** (state purpose for each point of engagement)?

-E.g., **Would the participant like to review the aggregated report** results to see how their data was used & have the ability to provide comment/feedback?

# Planning for data collection?

Various factors not discussed, but should be considered include but are not limited to

- Gantt chart
- Overall time management
- Ensuring data collected will help achieve study goal & scope
- etc.

# Assumptions

## Good vs. Bad assumption?

Assumption: Peat receives a carbon credit in the production phase of a process (post extraction)

**Take-home message:** Be careful about the assumptions you choose to use. Ensure the assumptions you apply are well-founded scientifically.

# Thank you & Questions

## Contact information

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<https://ie.ucdavis.edu>